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## AIR CONDITIONING SYSTEM

### BACKGROUND OF THE INVENTION

The present invention relates to an air-conditioning system comprising a plurality of indoor units and outdoor units connected thereto, or in particular to a large air-conditioning system used and suitably maintained in large buildings.

A conventional air-conditioning system of comparatively large scale is disclosed in JP-A-9-79654, for example, in which a plurality of air conditioners are known to be connected to a network through a gateway to meet the requirement of maintenance/control and system development.

An air-conditioning system is also described in JP-A-5-272795, wherein in order to reduce the cost of wiring various signal lines, the AC voltage of a power line for supplying power to the outdoor units and the indoor units is superposed with a power-line superposed signal such as a high-frequency signal of 10 to 450 kHz thereby to combine the signal line and the power line into a single common line.

In the prior art described above, a sufficient consideration fails to be given to the facts that the transmission line may be erroneously wired between the air conditioners, the operation data for the air conditioners are collected during the

inspection work, the wiring distance is limited by the data deterioration due to the wiring length and the environment, and the voltage or the number of phases may be different between each outdoor unit and the 5 corresponding indoor unit.

#### SUMMARY OF THE INVENTION

In view of the situation described above, the object of the present invention is to provide a layout-free air-conditioning system comprising a plurality of 10 air conditioners having different voltages or different numbers of phases, in which the wiring error of the transmission line is eliminated and the inspection work is facilitated thereby to reduce the burden on the construction workers and the maintenance persons.

15 In order to achieve the object described above, according to this invention, there is provided an air-conditioning system comprising:

a plurality of indoor units and a plurality of outdoor units each including a compressor, the air- 20 conditioning system being operatively controlled by transmitting and receiving the operation data between each of the indoor units and the corresponding one of the outdoor units;

an outdoor transmission/receiving unit 25 included in each of the outdoor units for transmitting by superposing the operation data on an outdoor power line for supplying power to the outdoor units and

receiving the operation data superposed on the outdoor power line;

an indoor transmission/receiving unit included in each of the indoor units for transmitting 5 by superposing the operation data on an indoor power line for supplying power to the indoor units and receiving the operation data superposed on the indoor power line;

an outdoor conversion unit for transmitting 10 by converting the operation data superposed on the outdoor power line into a radio signal and receiving and superposing the radio signal on the outdoor power line; and

an indoor conversion unit for transmitting by 15 converting the operation data superposed on the indoor power line into a radio signal and receiving and superposing the radio signal on the indoor power line.

In the air-conditioning system described above, the radio signal preferably contains the 20 operation data and an identification signal for determining whether the radio signal is required to be received.

Further, in the air-conditioning system described above, a remote controller for setting the 25 temperature preferably includes a transmission/receiving unit for receiving the radio signal.

Furthermore, the radio signal is preferably

received by a portable telephone, and the operation data is displayed on the portable telephone.

In addition, the air-conditioning system described above is preferably such that the radio 5 signal is transmitted from the portable telephone and received by the outdoor conversion unit or the indoor conversion unit thereby to control the operation.

Further, in the air-conditioning system described above, the radio signal preferably contains a 10 source address and a destination address as well as the operation data.

Furthermore, in the air-conditioning system described above, the radio signal preferably contains the operation data and an identification signal for 15 determining whether the radio signal is required to be received, and upon determination by the identification signal that the radio signal is required to be received, the outdoor conversion unit and the indoor conversion unit sample the radio signal and converts it 20 into a power-superposed signal.

What is more, in the air-conditioning system described above, the operation data is preferably received as a radio signal by and stored in a portable telephone.

25 Other objects, features and advantages of the invention will become apparent from the following description of the embodiments of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing an air-conditioning system according to an embodiment of the invention.

5 Fig. 2 is a block diagram showing a remote controller according to an embodiment of the invention.

Fig. 3 is a block diagram showing an air-conditioning system according to another embodiment of the invention.

10 Fig. 4 is a plan view showing the display screen of a portable telephone according to an embodiment of the invention.

DESCRIPTION OF THE EMBODIMENTS

An embodiment of the invention will be described in detail below with reference to the accompanying drawings. Fig. 1 is a diagram showing a configuration of an air conditioner comprising a power line connected with an outdoor unit 1 having a compressor mounted thereon, a power line 4 connected with an indoor unit 2, conversion units 6A, 6B for converting a signal superposed on the power line into a radio signal, and a central control unit 9 for controlling the operation of the air conditioner, wherein the outdoor unit 1 and the indoor unit 2 are interconnected by a pipe thereby to constitute a refrigeration cycle.

The outdoor unit 1 is supplied with three-

phase AC power of 200 V from the outdoor power line 3 and has mounted thereon an outdoor transmission/receiving unit 5A for the power-line superposed signal. The data (transmission information) defined as a basic 5 format is transmitted to the outdoor power line 3 through the outdoor transmission/receiving unit 5A for the power-line superposed signal. The data include the outdoor air temperature, the temperature of the gas discharged from the compressor, the condensing 10 temperature thereof, the high pressure and the low pressure, the drive frequency, the current value of the compressor, the opening degree of an expansion valve and the capability code. The basic format includes the data identification code, the length indicating the 15 data length, information about an air-conditioning system in the address, the source address, information about an air-conditioning system in the destination address and the destination address. The power- superposed data is converted into a radio signal by the 20 outdoor conversion unit 6A for the power-line superposed signal and the radio signal. In this signal conversion, the basic format of the outdoor transmission/receiving unit 5A has an exclusive bit for transmitting the radio signal with the flag set for the 25 bit as an identification signal. This identification signal facilitates the avoidance of an interference of the radio data. The radio signal has a frequency band of 2.4 GHz or 5.2 GHz since the lamp line or the radio

line is used as transmission media.

The indoor unit 2 is supplied with power from the indoor power line 4 of single phase, 100 V, and has mounted thereon the indoor transmission/receiving unit 5 5B. The indoor power line 4 is provided with the indoor conversion unit 6B. Further, the indoor conversion unit 6B at the data receiving end monitors the exclusive bit of the received data and determines from the state of the flag whether the data is the one 10 to be received or not. Specifically, the radio data transmission unit and the radio data receiving unit for communication of the radio data are set with each other in advance to raise a flag with the same bit by the switches included in the radio data conversion units 15 6A, 6B. The data thus converted into a radio signal is transmitted with a flag raised to the set bit. At the receiving end, the set bit is monitored and it is determined from the status of the flag whether the data is transmitted from the legitimate party of 20 communication. Once it is determined at the receiving end that the received data is transmitted from the legitimate party of communication, the indoor conversion unit 6B samples the radio signal for optimization of transmission, converts the data into 25 the power-superposed signal after shaping the waveform thereof, and transmits it to the indoor transmission/receiving unit 5B through the power line 4. By sampling the data at the time of conversion from

a radio signal to a cable signal, the optimization is carried out in terms of waveform shaping. In this way, the data deterioration is suppressed while at the same time making it possible to extend the wiring distance.

5           In collecting data by inspection of the air conditioner, a dedicated line for data is conventionally required to be connected to the air conditioner. The air conditioner according to this invention, in contrast, requires no such dedicated line  
10 but has the function of receiving a radio signal. In the case where the operation data in the form of a radio signal is received using a portable telephone, for example, the data can be collected and confirmed at any place where the radio signal reaches. Utilizing  
15 this fact, the wiring error of the transmission line between the air conditioners can be prevented.

The foregoing description refers to the data transmission from the outdoor unit 1 to the indoor unit 2. The data transmission from the indoor unit 2 to the  
20 outdoor unit 1 follows the reverse route.

The data is transmitted to the central control unit 9 for centralized control of a plurality of the outdoor units 1 and the indoor units 2 using a radio signal sent from the outdoor conversion unit 6A  
25 or the indoor conversion unit 6B to a central conversion unit 7S. The central conversion unit 7S converts the radio data to a signal transmissible on a transmission line 11. Also, the central control unit 9

is supplied with power of single phase, 100 V, from the central power line 12.

Fig. 2 shows the relation between the indoor unit 2 and a remote controller 8 for setting the 5 operation mode of cooling and heating, the room temperature and the direction of wind. The indoor unit 2 is supplied with power from the indoor power line 4 and has mounted thereon the transmission/receiving unit 5B for the power-line superposed signal. The indoor 10 unit 2 thus transmits the data to the indoor power line 4 through the indoor transmission/receiving unit 5B for the power-line superposed signal. The indoor conversion unit 6B converts the power-superposed data into a radio signal. The radio signal thus converted 15 is transmitted with the flag raised to make clear that the exclusive bit for identification included in the basic format represents the power-superposed data. The frequency band of the radio signal is 1 to 10 GHz, or preferably, 2.4 GHz. The remote controlled conversion 20 unit 7R mounted on the transmission line 11 of the remote controller 8 at the receiving end monitors the exclusive bit of the received data, and determines whether the data is communicable according to the presence/absence or the status of the flag with regard 25 to the source line and source address.

The remote controlled conversion unit 7R, once determined that the data is received from the legitimate party of communication, samples the data and

receives the radio data after optimizing it by waveform shaping or the like. Also, the data is transmitted from the remote controller 8 to the indoor unit 2 through the reverse route.

5                 Fig. 3 shows the state in which a plurality of the outdoor units 1 and a plurality of the indoor units 2 are connected, and the relation of the outdoor units 1 and the indoor units 2 with the portable telephone 10.

10               The air conditioner 1 has mounted thereon the outdoor transmission/receiving unit 5A for the power-superposed signal, and transmits the data to the outdoor power line 3 through the outdoor transmission/receiving unit 5A for the power-superposed signal. The power-superposed data is converted into a radio signal by the outdoor conversion unit 6A for conversion from the power-superposed signal into a radio signal. In the process, the radio signal is transmitted with the flat raised with an exclusive bit based on the contents set by the outdoor transmission/receiving unit 5A. The frequency band of the radio signal is 2.4 GHz. The portable telephone 10 at the receiving end of the radio signal monitors the exclusive bit of the received data and determines from the status of the flag whether the data is legitimate for communication.

               The portable telephone 10 at the receiving end, upon determination that the received data is

transmitted from the legitimate party of communication, extracts from the received data such data as the address numbers, the run/stop choice, the cooling/heating operation mode, the set temperature, 5 the model code and the fault code of the connected indoor unit 2 and the corresponding outdoor unit 1. Fig. 4 shows an example of a liquid crystal display making up the screen of the portable telephone 10, in which the operation data displayed in characters 10 include the address "INDOOR: 1" of the indoor unit 1 and the address "OUTDOOR: 1" of the corresponding outdoor unit. Also, the date of data extraction is indicated on the screen numerically, for example, as "2002/06/01", the fault code as "ALARM CODE: 03", the present 15 operating condition as "RUN/STOP: RUN", the cooling/heating mode as "OPERATION MODE: COOLING", the set temperature as "SET TEMP: 22°C" and "OUTDOOR AIR TEMP: 25°C". The extracted data are recorded in the internal storage unit of the portable telephone 10 and 20 used for maintenance and inspection.

As described above, even in the case where the indoor unit 2 and the outdoor unit 1 of the air conditioner have different voltages and different numbers of phases, or single phase, 100V, 50 Hz for the 25 indoor unit 2, and three phases, 200 V for the outdoor unit 1, for example, the data exchanged between the indoor unit 2 and the outdoor unit 1 are converted into a power-superposed signal and then transmitted as a

radio signal. Therefore, the wiring can be laid easily and the variance of arrangement of air conditioners can be increased.

Also, the operation data including the  
5 atmospheric temperature, the temperature of the gas  
discharged from the compressor, the condensation  
temperature thereof, the high pressure and the low  
pressure, the drive frequency and the current value of  
the compressor, the opening degree of the expansion  
10 valve, the capability code and the fault code can be  
extracted more easily using the portable telephone 10.

Further, the operating condition of each air  
conditioner and the data transmission between the air  
conditioners can be monitored by the portable telephone  
15 10 having the function of transmitting and receiving  
the radio signal. Specifically, the portable telephone  
10 at the receiving end determines whether the other  
party is legitimate for communication or not according  
to the status of the flag of an exclusive bit. The  
20 collected information to be monitored include the  
operating information (operation data) of each air  
conditioner, including the set temperature, the intake  
air temperature, the blowout air temperature, the  
indoor heat exchange temperature, the remote sensor  
25 temperature and the atmospheric temperature selected as  
desired by the user.

It will thus be understood from the foregoing  
description that according to this invention, even with

a comparatively large air conditioning system including  
a plurality of air conditioners, the construction, the  
maintenance/management and the system development can  
be facilitated regardless of the wiring distance or the  
5 difference of the voltage or the number of phases  
between the outdoor unit and the indoor unit.

It should be further understood by those  
skilled in the art that although the foregoing  
description has been made on embodiments of the  
10 invention, the invention is not limited thereto and  
various changes and modifications may be made without  
departing from the spirit of the invention and the  
scope of the appended claims.